EGNOS applications in aviation

- Performance Based Navigation (fixed wing)
- Navigation aid
- Performance based navigation for rotorcraft: RNP0.3, Pins LPV, SNI
- Automatic Depended Surveillance – Broadcast (ADS-B)
- Unmanned Vehicles Systems
Aviation moves towards GNSS for Navigation and Surveillance, increasing SBAS use

Key market trends:

• The aviation market continues to grow worldwide with reliance on GNSS increasing
• Regulators support expansion of PBN, result in increasing sales of GNSS/SBAS
• Rotorcraft operations are rapidly expanding their use of SBAS
RNP APCH deployment on the ground is driving increase of LPV capability on board

Over 45 operators in 18 countries approved and certified to fly LPV

No need for Specific approval anymore!
Increasing the EGNOS target market: LPV to non instrumental runways:

The challenge: LPV to non-instrument runway (ATS? Runway? MET/COM?)

Regulatory framework: The UK CAP 1122

“GA need help to increase GNSS approaches implementation and increase safety”
Paul Sherry, PPL/IR Europe.

Pilot cases in UK and Germany

- Egelsbach
- Perth
- Shelburn in Elmut
- Stapleford
- Haverfordwest

Potential market

- German: 777
- British: 420
- French: 475
- Italian: 366

EU28 – 2673 airports with non-instrument RWYs

Towards an harmonised implementation framework together with EASA
EGNOS supports demanding ADS-B applications while reducing ground infrastructure costs

**FAA ADS-B Out Mandate**

- Demanding operational requirements: 2NM separation for dependent parallel approaches
- *Mandate to equip all aircraft flying in certain airspace with ADS-B Out by 2020*
- WAAS recommended
- Performance equivalent to radar surveillance

**European Mandate**

- Most demanding ATS surveillance case: 3 NM separation
- *Mandate to equip* Aircraft with MTOM higher than 5700 kg or with maximum true air speed higher than 250 kts (2020)
- GPS receiver (ETSO-C129a) compliant is deemed to be sufficient

**EGNOS supports an overall CNS strategy**

Operators are using SBAS for PBN and ADS-B

When other applications are taken into account, upgrade costs are shared

ADS-B based on satellite technology can support ground infrastructure rationalisation
Increase demand for EGNOS based PBN operations for rotorcraft...

Example of operational PINS in Switzerland (Insel Hospital), used by REGA

Deployment ongoing in:
- Switzerland, Italy, Norway, France

Confirmed plans in 2018 in:
- Germany, United Kingdom, Spain, Czech Republic and Italy

Source: PildoLabs
...and operators are getting EGNOS on board

- Norsk Luftambulanse: 2 x EC-135, 2 x EC-145
- Sikorsky 92: 2 x Sikorsky 92
- Bristow: 6 x Sikorsky 92
- EC 135: 14 x EC-135
- EC 135P2+: 1 x EC 135P2+
- EC 135T2+: 1 x EC 135T2+
- AW109: 2 x EC-135, 2 x EC-145, 2 x EC-135
- EC 135P2+: 1 x EC 135P2+
- AW139: 1 x AW139
- Rotorcraft: 2 x AS355 & 1 EC135
- DSA a.s.
- SLOANE
- Babcock
...and operators are getting EGNOS on board

- 2 x EC-135
- 2 x EC-145
- 2 x Sikorsky 92
- 6 x Sikorsky 92
- 2 x AW109
- 1 x AS355
- 14 x EC135
- 2 x Rotorcraft: 1 AS355 & 1 EC135
- 1 x EC 135T2+
- 1 x EC 135P2+
- 1 x AW139

23 PinS
14 RNP 0.3 routes
29 rotorcraft retrofit
FLAG: Rotorcraft Working group for the harmonisation of PinS and Low Level routes implementation in Europe

Safety Guidance Material coming soon!
E-GNSS is an enabler for robust RPAS navigation

**Key market trends:**

- Drones will grow to outstrip any other user base in aviation
- For most ambitious applications in BVLOS, GNSS is the only choice
- Need of highly accurate and reliable performance, specially in professional applications
- Geofencing is required for most drones above 900g
GSA is supporting several geo-fencing test campaigns for proof of concept:

1. Precise take-off and landing on power substations
   - Range of BVLOS limited to 10km for testing
   - Flight along distribution line
   - Landing and take-off at same location (Non airport)

2. Geofencing test for aircraft inspection

3. Railway inspection

Showcase II: Firefighting operations
- Testing area in segregated airspace
- Take off and landing from existing airport
- Autonomous landing
Mikrokopter MKGPS V3 quadcopter:
- GPS, EGNOS, Galileo
- uBlox LEA-6S GNSS receiver
- Extra Septentrio AsteRX3 GNSS Rx
- Capable of defining and using geofence zones
- Results of on board GNSS receivers compared to ground reference station providing carrier differential GNSS (<5cm)

Conclusions:
• Use of EGNOS in position keeping and tracking resulted in more stable flight vs GPS alone
• Position errors with EGNOS < 1m vs > 2 m with GPS alone
• Geofencing capabilities improved by EGNOS: on time detection of no-fly zones

By: Dedicated to innovation in aerospace
SBAS ready RPAS receivers in the market

Receivers intended mainly for **Consumer** market

- Ublox
- Eagle Tree Systems

Receivers intended mainly for **Prosumer** market

- ComNav
- NVS
- Trimble

Receivers intended mainly for **Professional** market

- NovAtel
- SBG Systems
- Septentrio
- VectorNav
- weControl

* According to GSA Market report definition. Products are not exclusive to each category
GSA tools to boost EGNOS adoption in aviation
## Four main axis of action

<table>
<thead>
<tr>
<th>User needs</th>
<th>Partnership with <strong>user communities</strong> to address user needs</th>
</tr>
</thead>
</table>
| Support to regulation | **Aviation Task Force EASA/GSA/GROW/MOVE** with agreed workplans on:  
  - Fixed wing navigation, including LPV to non instrument RWY  
  - Rotorcraft navigation  
  - Drones navigation  
  - Surveillance, ADS-B |
| Towards the value chain | **Practical tools:**  
  - Cost/Benefit Analysis for Operators and Airports (navigation and surveillance)  
  - Guidelines on how to…  
  - Database on avionics |
| Funding for adoption & R&D | • EGNOS based operations and equipage  
  • **New applications** development  
  • **New receivers** development |
GSA funding for EGNOS operational implementation

- 12 Million €, 29 projects in 2 calls
- more than 100 EGNOS based approach procedures
- more than 15 operators equipped and certified for EGNOS based operations
- STC for 5 aircraft types with a potential retrofit solution for more than 260 aircraft in EU
- 6 EGNOS enabled simulators types
- More than 20 PinS and RNP0.3 routes for rotorcraft
- 3 EGNOS based RPAS operations

38 aircraft retrofits by 5 operators
GSA funding for EGNOS operational implementation

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Stay tuned!
3rd Call to be open in Q4 2017

More information at: https://www.gsa.europa.eu/gsa/grants
The investment is paying off!

Objective:
- Develop STC for upgrade of Saab 340
- Upgrade 10 Saab 340 aircraft with EGNOS capabilities

Status:
- Preliminary STC design completed
- Prototype aircraft upgraded
- Prototype aircraft successfully passed ground testing
- Prototype aircraft successfully passed in-flight testing, during a 3h23 minutes flight, with multiple LPV tests at Aarhus airport

Objective:
- Develop STC for upgrade of ATR42-500
- Upgrade 13 ATR42-500 aircraft of the HOP! (Air France) fleet towards EGNOS capabilities

Status:
- STC approved during summer 2017
- 7 aircraft already prewired, scheduled to activate upgrade before end of 2017

Objective:
- Upgrade of 6 Sikorsky S92 helicopters

Status:
- All aircraft have received their upgrade
- Training program for training pilots accepted by CAA and finalized

Tracking of in-flight testing

Prototype aircraft for first upgrade

Cockpit and cabin dismantled for upgrade
Avionics developed within the grants programme deliver solutions for over 260 aircraft of 30 different operators.

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>GSA grant project</th>
<th>STC developer</th>
<th>Avionics</th>
<th>Estimated fleet size in Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHC8-402</td>
<td>AirBaltic</td>
<td>CanardAerospace</td>
<td>UNS1-Ew</td>
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<td>JetStream41</td>
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<td>Saab2000</td>
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<td>Saab340</td>
<td>NextJet</td>
<td>Scandinavian Avionics</td>
<td>UNS1-Ew</td>
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<tr>
<td>ATR42-500</td>
<td>HOP!</td>
<td>AeroConseil</td>
<td>CMC</td>
<td>25</td>
</tr>
</tbody>
</table>
Staying close to users to provide first hand answers to your needs

**GSA-European Business Aviation Association LPV WG**

- LPV implementation to priority aerodromes
- Guidance on operation approval
- Retrofit solutions availability for the EBAA fleet

**Last meeting:**

- Brussels, 22 Sep

**European Regional Airlines Association-Operations Group**

- Enable LPV operations to priority airports
- Foster development of avionics solutions for E-GNSS operations
- Increase awareness of EGNOS RNP APCH benefits to regional airports

**ERA General Assembly, Operations group:**

- Athens 17-19 Oct

**FLAG-Rotorcraft Working Group**

- Harmonise implementation of EGNOS based Rotorcraft operations
- Address operational and regulatory aspects
- Identify service provision needs
- Compliance criteria
- Validation of new concepts

**FLAG workshop**

- Barcelona, 30 Nov-1 Dec
THANK YOU FOR YOUR ATTENTION

Carmen Aguilera
Aviation and R&D Market Development Officer, GSA
Carmen.Aguilera@gsa.europa.eu
www.gsa.europa.eu
All major avionics manufacturers have EGNOS ready products available.

<table>
<thead>
<tr>
<th>Avionics certified to ETSO C145 or C146 (SBAS)</th>
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<tbody>
<tr>
<td><strong>GARMIN</strong></td>
</tr>
<tr>
<td>GNS 430W / 530W</td>
</tr>
<tr>
<td>GTN 6XX / 7XX TS</td>
</tr>
<tr>
<td><strong>AVIDYNE</strong></td>
</tr>
<tr>
<td>G1000, G2000, G3000, G5000</td>
</tr>
<tr>
<td><strong>BendixKing</strong></td>
</tr>
<tr>
<td>IFD540 &amp; IFD440 TS</td>
</tr>
<tr>
<td><strong>Rockwell Collins</strong></td>
</tr>
<tr>
<td>GPS-4000S</td>
</tr>
<tr>
<td><strong>Universal Avionics Systems Corporation</strong></td>
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<td>UNS-1Ew, -1Lw, -1Fw</td>
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<tr>
<td><strong>Honeywell</strong></td>
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<tr>
<td>KGS 200 (Primus Apex /Easy II)</td>
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<td><strong>Esterline</strong></td>
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<tr>
<td>CMA 5024 GLSSU</td>
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<tr>
<td><strong>THALES</strong></td>
</tr>
<tr>
<td>Topstar 200 LPV</td>
</tr>
</tbody>
</table>

EGNOS

EASA cert. pending
Table of Contents

- EWA
- LPV Implementation Status
- EWA for non-EU Countries
- EGNOS at Non-instrument RWY
IFR/SBAS benefits

- **Enhance Safety** due to instrumental aids and space-based vertical guidance for the approach procedure.
- **Increases airport accessibility**
- **Reduces environmental impact**
- **Higher performances** → **Lower minima**
- **LPV Procedure is ILS look alike**
- **Not Temperature/Pressure dependent**
- **No RAIM check**
- **No ground infrastructure at the airport**
LPV: WHO DOES WHAT?

EGNOS Service Provider
Certified as SES ANSP (Navigation)
EGNOS SoL Service Safe introduction
EGNOS DoV produced

ATS Service Provider
Certified as SES ANSP
Standard Approach Procedure Approval Process:
- Operational Safety Assessment
- IFP Design (PANS-OPS)
- Flight Validation, etc.
- Specific National Requirements

Airlines / Operators
Airworthiness/ops app. (AMC-20-27/28, TGL 2/10)
Authorised Equipment (ETSOs C144,C145 or C146)
Crew Trained/Qualified, etc.
EWA
Provides support to ANSPs
Complies with Applicable Regulation
Working Interfaces
EGNOS SoL Service Definition Document (SDD)
Service Arrangements
NOTAM Proposal Origination
GNSS Data Recording (incident/accident investigation)
Collaborative Decision Making (CDM)
Contingency Management
Airport Data Tool (to register new EGNOS based procs)

EGNOS Working Agreement

Compliant NSA

EASA

EWA
LPV Implementation Status - EWAs

56 EWAs in place

- EU Members

EGNOS Service Provision Workshop 2017
LPV Implementation Status - EWAs

56 EWAs in place

- EU Members: 22
- Non-EU Members: 4

EGNOS Service Provision Workshop 2017
56 EWAs in place

EWAs per country

- 1 EWA
- 2 EWAs
- 3 EWAs
- 4 EWAs
- 21 EWAs
## LPV Implementation Status

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>Airports</th>
<th>LPV Procedures</th>
<th>RNP 0.3 Procs</th>
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<tr>
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<td>APV-I</td>
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<td><strong>29</strong></td>
<td><strong>5</strong></td>
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</table>

14th September 2017
LPV Implementation Status - Plans

2011

LPV Procedures evolution

The journey begins...

Juno is launched

EGNOS Service Provision Workshop 2017
LPV Implementation Status - Plans

2013

LPV Procedures evolution

The journey begins...

Juno is launched

Juno is half-way to Jupiter

... it continues...

3-4/10/2017
LPV Implementation Status - Plans

The journey begins...

- Juno is launched
- Juno is half-way to Jupiter
- NASA is preparing the arrival to Jupiter

...it continues...

2015

LPV Procedures evolution
EGNOS Working Agreements for non-EU countries

- Existing EWAs with non-EU countries (compliant with SES Regulation):
  - Bailiwick of GUERNSEY (Channel Islands – 2011).
  - Switzerland (2011).
  - Norway (2013).
  - Bailiwick of JERSEY (Channel Islands – 2014).

- Explicit interest expressed by several neighboring regions/countries:
  - An **International Agreement** (between EC and the non-EU State), defining the overall framework for the use of the EGNOS SoL Service.
  - An **agreement/coordination scheme**: if deemed necessary between EASA and the Civil Aviation Authority of the non-EU country.
  - **EWA** (EGNOS Working Agreement with ESSP): Established on the basis of the previous agreement/s.
EGNOS Working Agreements for non-EU countries

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General Aviation
6 Objectives we are committed

IFR Flying
Easier access of GA pilots to IFR rating, as a concrete measure that will improve safety.

Training
By end of 2018 the 3rd option for licensing will be fully developed providing a simple system for pilot training outside ATO.

Part-M ‘Light’
Work towards a simpler and more proportionate framework for aircraft maintenance and license: a Part-M ‘Light’.

Technology
Continue development of CS-STAN and other similar tools to enable the introduction of new technologies which contribute to safety.

Simpler Certification
Towards a simpler framework for certifying LSA aircraft in the short term by increasing the support to applicants e.g. workshops, document templates etc. In the long term by amending applicable regulations in order to bring a radical simplification.

Industry standards
Build on the improvements of CS-23/Part-23 on other CS or regulations in order for EASA to focus on its safety objectives and to delegate the preparation of associated standards to industry groups (ASTM, ASD etc.)
EASA Roadmap for GA

IFR Flying
Easier access of GA pilots to IFR rating, as a concrete measure that will improve safety.

6 Objectives we are committed

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RNP APCH - Non instrument RWY – non towered AD
Current VFR scenario

VFR
Visual approach Chart

ARRIVALS
VFR traffic bound for Teruel AD shall remain in the A/A frequency. Entry into ATZ shall be via the established routes to join the aerodrome traffic circuit, communicating its position at the points N (Junction over A-23, Villarquemado link), W (Gea de Albarracin) and E (Junction over A-23, N-420 link). Entry into air traffic circuit, on downwind and final segments shall be no ified.

Aircraft joining the circuit shall overfly the aerodrome maintaining 2000 ft AGL. They must then descend to circuit height on the inactive (dead) side of the RWY in use and join the circuit by crossing the upwind end of the RWY in use.

Aircraft joining directly on the crosswind leg must arrange their flight to track over the upwind end of the RWY in use, in the same position as if approaching it from the ‘deadside’. This must be at circuit height.

VFR-No instrumental guidance

Class G

AD Traffic circuit

AERODROME WITHOUT CONTROL SERVICE
The frequency is only available for AIR/AIR communications.

AD SIN / WITHOUT ATS
FREQ A/A  122.675

EGNOS
EGNOS, it's there. Use it.
RNP APCH - Non instrument RWY – non towered AD
New scenario – Actors involved

IFR – RNP APCH
down to LPV minima

SBAS capable A/C

3D, IFR
'similar to PinS'

Class E
1000 ft
Class G

DA/H

RNAV (GNSS) RWY05 OUESSANT AD (FR)

EGNOS
Navigation service provider
missed approach

UNICOM
A/A, A/G frequency

CAA
AIS
NOTAM Info
MET
QNH, VMC/IMC conditions
AD operator
Non instrument RWY
Thanks for your attention!

Now it’s your turn!